Section II. REMARKS

Allowance of Claims 42-48 and Rewriting of Allowable Claims 8-10, 15-19, 26, 28-29, 32-34, 39

Applicants hereby acknowledge the allowance of claims 42-48.

Further, Applicants have herein rewritten the allowable claims 8, 10, 15, 26, 28, 32, and 39, from which claims 9, 16-19, 29, and 33-34 depend, into independent claims, as required by the Examiner in the June 3, 2004 Office Action

Therefore, claims 8-10, 15-19, 26, 28-29, 32-34, 39, and 42-48 are fully in form and condition for allowance.

Response to Rejection of Claims 1, 3-5, 7, 11-14, 20-21, 23-25, 27, 30-31, 35-38, 40-41, and 49-51

In the June 3, 2004 Office Action, the Examiner finalized the rejection of claims 1, 3-5, 7, 11-14, 20-21, 23-25, 27, 30-31, 35-38, 40-41, and 49-51 on various reference grounds. Specifically, the Examiner rejected:

claims 1, 2, 4-6, 11-14, 21, 22, 25, 27, 30, 31, 35-38 and 51 under 35 U.S.C. §102(b) as being anticipated by **Kosakowski** et al. U.S. Patent No. 5,575,888 (hereinafter "Kosakowski");

claims 35-37 under 35 U.S.C. §102(b) as being anticipated by **Matsumoto** et al. U.S. Patent No. 5,492,855 (hereinafter "Matsumoto");

claims 1, 4, 5, 7, 11, 14, 20, 21, 25, 27 and 30 under 35 U.S.C. §103(a) as being obvious over **Fuller** et al. U.S. Patent No. 4,659,426 (hereinafter "Fuller");

claims 12 and 13 under 35 U.S.C. §103(a) as being unpatentable over **Fuller** in view of **Shih** et al. U.S. Patent Application Publication No. 2002/0066532 (hereinafter "Shih");

claims 1, 4, 5, 11, 21 and 27 under 35 U.S.C. §103(a) as being unpatentable over **Matsumoto** in view of **Fuller**; and

claims 3, 11, 23, 24, 27, 40, 41, 49 and 50 under 35 U.S.C. §103(a) as being unpatentable over **Kosakowski**.

In response, Applicants have herein amended independent claims 1, 21, 35, 49, 50, and 51, from which claims 3-5, 7, 11-14, 20, 23-25, 27, 30-31, 36-38, and 40-41 respectively depend.

Applicants respectfully traverse the Examiner's claim rejections, for the following patentable distinctions between Applicants' claimed invention and the cited references.

Patentable Distinction of Claims 1, 3-5, 7, 11-14, and 20 over the Cited References

The amended claim 1 of the present application, from which claims 3-5, 7, 11-14, and 20 depend, recites:

> "A plasma-assisted dry etching method for etching an Ir-based noble metal material, said method comprising:
>
> contacting the Ir-based noble metal material with an energized plasma composition comprising an etching species mixture for sufficient time to at least partially etch said Ir-based noble metal material, wherein **the etching species mixture comprises (i) at least one halogenated compound** selected from the group consisting of organic halogenated compounds, inorganic halogenated compounds and mixtures thereof, and **(ii) an oxidizing agent selected from the group consisting of O_2 and O_3 gases**, wherein **the volumetric ratio of said at least one halogenated compound over said oxidizing agent is in a range of from about 4 to about 0.5**, and wherein the energized plasma composition contacting the Ir-based noble metal material lacks nitrogen- and phosphorous-containing species."

It is clear that claims 1, 3-5, 7, 11-14, and 20 of the present application expressly require an etching species mixture that comprises both a halogenated compound and an oxidizing agent selected from the group consisting of O_2 and O_3 gases, with the volumetric ratio of the halogenated compound over the oxidizing agent ranging from about 4 to about 0.5.[1]

Kosakowski discloses an etching process wherein the refractory metals are *intermittently* exposed to O_2 or air to passivate, e.g., mask, the nascent sidewalls of the refractory metal (see Kosakowski, col. 6, lines

[1] The instant specification describes on page 12, paragraph [0037] that the continuous volumetric flow ratio of a halogenated compound (C_2F_6) over an oxidizing agent (O_2) can preferably be on the order of "from about 4 to about 0.5."

24-27). **Kosakowski** further teaches that the intermittent exposure, as opposed to continuous exposure, requires stoppage of the plasma etch process, evacuation of the etching plasma, and venting of the reaction chamber to the ambient atmosphere (see Kosakowski, col. 3, lines 3-31).

Clearly, the O_2 or air, as intermittently introduced into the etching chamber after stoppage of the plasma etch process, evacuation of the etching plasma, and venting of the reaction chamber to the ambient atmosphere, is NOT mixed with the etching plasma that contains fluorinated organic or inorganic etchant (see Kosakowski, column 2, lines 39-44) in the process disclosed by **Kosakowski**.

Therefore, **Kosakowski fails to teach or suggest an etching species mixture that contains both a halogenated compound and an oxidizing agent selected from O_2 or O_3, as expressly required by Applicants' claims 1, 3-5, 7, 11-14, and 20.**

Matsumoto discloses a fine pattern dry etching process for Pt electrodes using RF power sources, wherein the Pt etching speed is increased by the formation of more volatile Pt and S alloys during etching. Specifically, **Matsumoto** teaches that either H_2S or SO_2 gas can be added into the etching gas mixture as the S source.

However, claims 1, 3-5, 7, 11-14, and 20 expressly require **an etching gas that comprises an oxidizing agent selected from O_2 and O_3 gases, which is neither taught nor suggested by Matsumoto in any manner.**

In the June 3, 2004 Office Action, the Examiner required Applicants to provide a sworn affidavit in support of Applicants' position that SO_2 does not dissociate under plasma conditions, in addition to the scientific proof that Applicants had already provided in the March 3, 2004 Response.[2]

MPEP 704.11 provides that "a requirement [for information] under 37 CFR 1.105 may only be made when the examiner has a reasonable basis for requiring information."

In this case, the Examiner has not shown any reasonable basis for the requirement of a sworn affidavit.

[2] On page 18 of the March 3, 2004 Response, Applicants have shown that "[t]o free one oxygen atom from the SO_2 molecule at the O=SO bond, 553 kJ mol^{-1} of energy is needed, which corresponds to 9.19×10^{-22} kJ of energy," that "[t]he most energetic radio waves, corresponding to wavelengths of approximately 10 cm, have corresponding energies of 1.99×10^{-27} kJ, which is NOT enough to sever the O=SO bond" and that "Matsumoto does not teach the release of oxygen from SO_2."

The Examiner's mere disbelief of the scientific proof already provided by Applicants, unexplained by any reason and unsupported by any evidence, is not a reasonable basis for such requirement.

Applicants therefore request the Examiner to explain the reasons of his disbelief of the scientific proof already provided by Applicants and to provide evidentiary support for such disbelief.

Fuller discloses a method for etching metals or metal composites by using a reagent gas mixture including a halogen based gas with a carbonyl source such as carbon monoxide or carbon dioxide in a plasma reactor (see Fuller, column 2, lines 47-54). **Fuller** further teaches that helium or oxygen gas may be added to the plasma reactor to obtain the desired control of substrate temperature and photoresist erosion (see Fuller, column 4, lines 34-37).

However, **nothing in Fuller teaches or suggests that the halogen based gas and the oxygen gas have a volumetric ratio in a range of from about 4 to about 0.5**, as expressly required by claims 1, 3-5, 7, 11-14, and 20 of the present application.

On the contrary, **Fuller** discloses on column 5, lines 13-19 a plasma etching process in which carbon tetrachloride (i.e., the halogen based gas) was fed at 10 SCCM and oxygen was fed at 2 SCCM, resulting in an etch gas mixture having the halogen based gas and the oxygen gas at **a volumetric ratio of about 5** (=10:2), which is beyond the range (i.e., **from 4 to about 0.5**) expressly required by claims 1, 3-5, 7, 11-14, and 20. Nothing in Fuller teaches or suggests the modification of such plasma etching process, by providing more oxygen thereto or by reducing the amount of halogen based gas added.

Therefore, **Fuller does not provide any derivative basis for an etch species mixture that comprises a halogenated compound and an oxidizing agent selected from O_2 and O_3 gases at a volumetric ratio ranging from about 4 to about 0.5, as required by claims 1, 3-5, 7, 11-14, and 20 of the present application.**

Neither the **Shih** reference nor the **Matsumoto** reference remedies such deficiency of Fuller.

Therefore, Applicants' claimed invention as recited by claims 1, 3-5, 7, 11-14, and 20 patentably distinguishes all the cited references **Kosakowski, Matsumoto, Fuller,** and **Shih,** by requiring an etching species mixture that comprises both a halogenated compound and an oxidizing agent selected from the

group consisting of O_2 and O_3 gases, with the volumetric ratio of the halogenated compound over the oxidizing agent ranging from about 4 to about 0.5.

Further, claim 3 expressly requires that "**the etch species mixture comprises C_2F_6 and O_2.**"

As described on page 12, paragraph [0039] of the instant specification, the use of C_2F_6 as a source material in the etchant medium extends the active life of the radicals formed by the O_2 gas and provides a moderate distance between the generating and reacting regions.

Therefore, the use of an etching species mixture comprising both C_2F_6 and O_2, as required by claim 3, achieves **an unexpected and superior result**, i.e., more effective etching due to the extended active life of the O_2 radicals and the adjusted distance between the generating and reacting regions.

None of the cited references discloses an etching species mixture comprising both C_2F_6 and O_2; nor do they even contemplate the advantage of using such etching species mixture.

Thus, claim 3 of the present application further distinguishes over the cited references, by requiring that the etch species mixture comprise C_2F_6 and O_2.

Patentable Distinction of Claims 21, 23-25, 27, and 30-31 over the Cited References

The amended claim 21 of the present application, from which claims 23-25, 27, and 30-31 depend, recites:

> "A method of fabricating a microelectronic device structure, comprising:
>
> (a) depositing an Ir-based noble metal material on a substrate;
>
> (b) forming a pattern on the deposited Ir-based noble metal material of a desired configuration;
>
> (c) contacting the deposited Ir-based noble metal material with an energized plasma comprising an etching species mixture, to thereby etch the Ir-based noble metal material, wherein **the etching species mixture comprises (i) at least one halogenated compound** selected from the group consisting of organic halogenated compounds, inorganic halogenated and mixtures thereof, and **(ii) an oxidizing agent selected from the group consisting of O_2 and O_3 gases**, wherein **the volumetric ratio of said at least one halogenated compound over said oxidizing agent is in a range of from about 4 to about 0.5**, and wherein the energized plasma composition contacting the noble metal material lacks nitrogen-and phosphorous-containing species; and

> (d) continuing step (c) for a sufficient time and under sufficient conditions to form the microelectronic device structure or a precursor thereof."

Like claims 1, 3-5, 7, 11-14, and 20, claims 21, 23-25, 27, and 30-31 of the present application also expressly require an etching species mixture that comprises both a halogenated compound and an oxidizing agent selected from the group consisting of O_2 and O_3 gases, with the volumetric ratio of the halogenated compound over the oxidizing agent ranging from about 4 to about 0.5.

Therefore, claims 21, 23-25, 27, and 30-31 patentably distinguish all the cited references, for the same reasons provided hereinabove in support of the patentability of claims 1, 3-5, 7, 11-14, and 20.

Patentable Distinction of Claims 35-38, 40-41, and 51 over the Cited References

The amended claims 35 (from which claims 36-38 and 40-41 depend) and 51 both recite:

> "... **a gas-phase reactive composition comprising (i) a halide component**..., and **(ii) an oxidizing gas selected from the group consisting of O_2 and O_3**..., wherein **the volumetric ratio of said halide component over said oxidizing gas is in a range of from about 4 to about 0.5**..."

Similar to claims 1, 3-5, 7, 11-14, and 20, claims 36-38 and 40-41 of the present application require a gas-phase reactive composition that comprises both a halide component and an oxidizing agent selected from the group consisting of O_2 and O_3 gases, with the volumetric ratio of the halide component over the oxidizing agent ranging from about 4 to about 0.5.

Therefore, claims 36-38, 40-41, and 51 patentably distinguish all the cited references, for reasons similar to those provided hereinabove in support of the patentability of claims 1, 3-5, 7, 11-14, and 20.

Patentable Distinction of Claims 49 and 50 over the Cited References

Claim 49 as amended herein recites:

> "A method for removing from a microelectronic device structure a noble metal residue including at least one metal selected from the group consisting of platinum, palladium, iridium and rhodium, the method comprising:

> contacting the microelectronic device structure with **a gas-phase reactive composition comprising: (i) SiF_4** in a sufficient amount to at least partially remove noble metal residue, and **(ii) an oxidizing gas selected from the group consisting of O_2 and O_3 gases,**
>
> wherein **the volumetric ratio of SiF_4 over said oxidizing gas is in a range of from about 4 to about 0.5**."

Claim 50 as amended herein recites:

> "A method for removing from a microelectronic device structure a noble metal residue including at least one metal selected from the group consisting of platinum, palladium, iridium and rhodium, the method comprising:
>
> contacting the microelectronic device structure with **a gas-phase reactive halide composition comprising (i) Si_2F_6** in a sufficient amount to at least partially remove noble metal residue, and **(ii) an oxidizing gas selected from the group consisting of O_2 and O_3 gases,**
>
> wherein **the volumetric ratio of Si_2F_6 over said oxidizing gas is in a range of from about 4 to about 0.5**."

Kosakowski discloses use of SiF_6 as the etchant from which the etching plasma may be formed (see Kosakowski, column 2, lines 40-42).

Nothing in **Kosakowski** teaches or suggests uses of SiF_4 or Si_2F_6 as the etchant.

None of the other cited references, **Matsumoto**, **Fuller**, and **Shih**, remedies such deficiency of **Kosakowski.**

Further, as explained hereinabove, none of the cited references provides any derivative basis for a gas-phase reactive halide composition that comprises a halide component and an oxidizing agent selected from O_2 and O_3 gases at a volumetric ratio ranging from about 4 to about 0.5.

Therefore, **claim 49 of the present application patentably distinguishes over all the cited references, by requiring a gas-phase reactive halide composition that comprises both SiF_4 and an oxidizing agent selected from O_2 and O_3 gases at a volumetric ratio ranging from about 4 to about 0.5**, and **claim 50 patentably distinguishes over all the cited references, by requiring a gas-phase reactive halide composition that comprises both Si_2F_6 and an oxidizing agent selected from O_2 and O_3 gases at a volumetric ratio ranging from about 4 to about 0.5**.

Payment of Fees

The fee payable in respect of the rewriting of allowable claims 8, 10, 15, 26, 28, 32, and 39 in independent form is calculated below.

Type of Claims	Number of Original Claims	Number After Amendment	Amount Payable
Independent	7	14	$602
Total	51	48	$0
Amount Payable			$602

The Office is hereby authorized to charge the fee of $602.00 for the rewriting of such claims to Deposit Account No. 50-0860 of Advanced Technology Materials, Inc., 7 Commerce Drive, Danbury, CT 06810.

Please charge any deficiency and credit any excess payment to Deposit Account No. 50-0860 of Advanced Technology Materials, Inc.

CONCLUSION

Based on the amendments made herein and the foregoing remarks, all pending claims 1, 3-5, 7-21 and 23-51 are now in form and condition for allowance. The Examiner therefore is respectfully requested to reconsider and allow such claims.

Respectfully submitted,

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